INDOOR AIR QUALITY REASSESSMENT

Grafton Municipal Building
30 Providence Road
Grafton, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of the Grafton Board of Health, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Grafton Municipal Building (GMB), Grafton, MA. Concerns about symptoms (e.g., dry itching eyes, headaches, fatigue and respiratory irritation) believed to be attributed to poor indoor air quality prompted this inspection.

On December 23, 2002, a visit was made to the building by Michael Feeney, Director of BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program, to conduct an indoor air quality assessment. The GMB is a two-story brick building originally built in 1950 as a school. The building consists of a former classroom wing with a gymnasium and auditorium wing. Town offices are located on the first floor and in several second floor offices of the former classroom wing. At the time of assessment, the gymnasium and auditorium wing were under renovation into a senior center, however, the bulk of the renovation had been completed. Painting and other punch-list activities were observed in the senior center during the visit. Most of the offices are carpeted and windows are openable throughout the building.

Actions on Recommendations Previously Made by MDPH

BEHA staff had previously visited the building in June 2000 and issued a report that made recommendations to improve indoor air quality (MDPH, 2000). A summary of actions taken on previous recommendations is included as Appendix I of this reassessment.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The building has a staff of approximately 20. The tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the table that carbon dioxide levels were below 800 parts per million of air (ppm) in all areas surveyed, which indicates adequate ventilation in occupied areas of the building. Fresh air in classrooms and most office space is supplied by a unit ventilator (univent) system. A univent draws fresh air from a vent on the exterior of the building and air from the classroom (called return air) through a vent in the base of the unit (see Figure 1). Fresh air and return air are mixed, filtered, heated and expelled into the classroom through a fresh air diffuser located on the top of the unit. Univents were operating in all occupied offices throughout the building. Obstructions to airflow, such as paper and boxes in front of univent return vents were noted in one area. In order for univents to provide fresh air as designed, univent air diffusers and return vents must remain free of obstructions.

Exhaust ventilation is provided by grilled, ducted wall vents powered by roof top motors. Exhaust vents were operating and drawing air during the assessment.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of building occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment, however air testing in this building indicates that adequate ventilation currently exists .

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (BOCA, 1993; SBBRS, 1997). The ventilation must be on at all times when the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated

temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix II.

Temperature readings ranged from 70° F to 79° F, which were very close to the BEHA recommended range for comfort. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. Temperature complaints were reported to BEHA staff in a number of areas. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 23 to 44 percent, which was below the BEHA recommended comfort range in most areas. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A number of rooms had water-stained ceilings and ceiling tiles, which are evidence of roof and/or plumbing leaks. Water-damaged ceiling tiles can provide a source of mold and mildew growth and should be replaced after a leak is discovered.

Several rooms had a number of plants. Plant soil and drip pans can serve as sources of mold growth. Plants are also a source of pollen. In some areas flowering plants were noted near univent air diffusers. Plants should be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold.

The Board of Assessors office had several boxes placed around the return air vent of the univent. One of these boxes appeared to be water damaged with visible mold colonies on its surface. By storing this box next to the univent, mold, spores and other materials associated with fungal growth can be captured by the return vent air stream a distributed into the room. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials (e.g., carpet) be dried with fans and heating within 24 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur.

Humidifiers were observed in several areas. This type of humidifier uses a rotating wheel that has sponges along its edge to dip into a water reservoir. An air stream is directed over the wet sponge material, which aerosolizes water vapor. These humidifiers appear to be at least ten years old. GMB staff report that the humidifiers have been cleaned. Humidifiers should be cleaned frequently in a manner consistent with manufacturer's instructions. Failure to do so can make a humidifier a source of microbial growth, which is then distributed into occupied space during its operation (US EPA, 1991). The configuration of this humidifier makes frequent cleaning difficult, thus rendering this unit prone to microbial growth.

Other Concerns

Several other conditions were noted during the assessment that can affect indoor air quality. The Board of Assessors office has a photocopier located in front of the univent return vent. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). In this configuration, the univent may draw waste heat, ozone and VOCs and enhance the distribution of these materials into the room.

Office areas contained window-mounted air conditioners. Portable air-conditioning units are normally equipped with filters, which should be cleaned or changed as per the manufacturer's instructions to avoid the build up and re-aerosolization of dirt, dust and particulate matter.

Conclusions/Recommendations

In view of the findings at the time of our inspection, the following recommendations are made:

1. To maximize air exchange, continue to operate both supply and exhaust ventilation continuously during periods of occupancy independent of thermostat control.
2. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
3. Repair any existing water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
4. Move plants away from univents. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
5. Consider replacing aging humidifiers.
6. Remove mold colonized boxes stored in the Board of Assessors office.

7. Examine feasibility of relocating photocopier away from univent.

8. Clean/replace filters in window-mounted air conditioners as per the manufacture's instructions.

References

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US EPA. 2001. Mold Remediation in Schools and Commercial Buildings. US Environmental Protection Agency, Office of Air and Radiation, Indoor Environments Division, Washington, D.C. EPA 402-K-01-001. March 2001. http://www.epa.gov/iaq/molds/mold_remediation.html

US EPA. 1991. Indoor Air Facts No. 8 Use and Care of Home Humidifiers. US Environmental Protection Agency, Office of Air and Radiation, Office of Research and Development, Washington, DC. February 1991.

TABLE 1-1

Indoor Air Test Results – Grafton Town Offices – Grafton, Massachusetts December 23, 2002

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	259	42	32					
Board of Health	383	68	24	2	Y	Y	Y	CT 2, door open WAC
Planning Board	398	71	23	2	Y	Y	Y	WAC Door open
Board of Selectmen	474	72	22	4	Y	Y	Y	WAC Door open
Town Collector	414	73	22	2	Y	Y	Y	WAC Door open
Town Accountant	449	74	22	2	Y	Y	Y	WAC Door open
Board of Assessors	414	74	21	2	Y	Y	Y	Photocopier, CT 2 WD box, door open
Committee Meeting Room	440	76	21	0	Y	N	N	Door open
Town Clerk	526	75	23	2	Y	N	N	Rodents Door open
Building Inspector	377	74	19	1	Y	Y	Y	
Highway Department	429	72	20	1	Y	Y	Y	

*** ppm = parts per million parts of air**
CT = water damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1-2

Indoor Air Test Results – Grafton Town Offices – Grafton, Massachusetts December 23, 2002

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Highway Department	399	72	19	2	Y	Y	Y	Plants Door open
Board of Sewer Commissioner	438	71	20	1	Y	Y	Y	Door open

*** ppm = parts per million parts of air**
CT = water damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Appendix I

The following is a status report of action(s) taken on previous BEHA recommendations (**in bold**) based on reports from town/building staff, documents, photographs and BEHA staff observations.

1. **To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy independent of thermostat control.**

   Action taken: Univents were repaired. All univents were operational in all town offices assessed.

2. **Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers building-wide.**

   Action taken: See ventilation section of main report.

3. **Operate cafeteria ventilation system during hours of school operation to remove odors and to circulate air.**

   Action taken: The cafeteria area was under renovation at the time of this assessment. Town offices are not located in this area.

4. **Restore exhaust ventilation in classrooms and office space. Examine rooftop exhaust motors for proper function; repair and replace parts as needed.**

   Action taken: Exhaust motors were repaired. All exhaust vents were operational and drawing air in town offices assessed.

Appendix I

5. Remove all blockages from univents and exhaust ventilators to ensure adequate airflow.

Action taken: Univents were blocked in several offices (see Tables).

6. **Once both the fresh air supply and exhaust ventilation are functioning, the systems should be balanced by a ventilation engineer.**

Action taken: See ventilation section of main report

7. **For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).**

Action taken: A new vacuum clean equipped with HEPA filtration was purchased. In addition, students were relocated from building, therefore decreasing dirt/dust generation related to foot traffic.

8. **Repair/replace any water-stained ceiling tiles and wall plaster. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial. Determine source of water entry through wall and eliminate.**

Action taken: Ceiling tiles were replaced in most offices. Several stained ceiling tiles remained.

Appendix I

9. **Move plants away from univents in classrooms. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.**

   Action taken: Some offices still contained plants on univents.

10. **Clean humidifiers and dehumidifiers regularly and maintain as per the manufacturer's instructions to prevent microbial growth and/or unpleasant odors.**

    Action taken: Some humidifiers remain in the building. No odors or visible mold growth were detected in these units. These devices are of a type and age that may be difficult to clean. Replacement of these devices with a more modern/more easily cleaned humidification system would be advisable.

11. **Replace missing ceiling tiles to prevent the egress of dirt, dust and particulate matter between rooms and floors.**

    Action taken: No missing ceiling tiles were observed in occupied areas.

12. **Cap abandoned pipes in cafeteria to prevent sewer gas back up.**

    Action taken: The cafeteria area was under renovation at the time of this assessment. Town offices are not located in this area.

13. **Consider insulating copper pipes and/or removing carpeting around pipes in the Town Clerk's Office to avoid condensation and the potential of mold growth on carpeting.**

    Action taken: This action was reportedly completed.

Appendix I

14. **Re-activate or replace wall-mounted exhaust vent in art room and teacher's lounge to help circulate air and remove heat and odors.**

    Action taken: School operations were moved from this building, therefore removing the kiln from the building.

15. **Relocate student drop off area or have busses shut off engines after five minutes as required by Massachusetts General Laws 90:16A. To avoid entrainment of vehicle exhaust (see Picture 12), post signs in parking area instructing employees not to back in.**

    Action taken: School operations were moved from this building, therefore removing busses from close proximity to the building.

16. **Change filters in window-mounted air conditioners as per the manufacturer's instructions to prevent the re-aerosolization of dirt, dust and particulate matter.**

    Action taken: More work is needed in this area.

17. **Examine the feasibility of installing local exhaust ventilation for odor generating equipment in the AV room.**

    Action taken: School operations were moved from this building, removing the AV equipment to the new building.

18. **Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.**

    Action taken: School operations were moved from this building reducing the amount of accumulated items.